The present invention relates to a pallet foot for a pallet according to the preamble of claim 1.

Such a pallet foot is known from US-A-3,602,158 and comprises cut-to-size board, which is provided with indentations. In US-A-5,365,857 mainly corrugated board or multilayer paper is used, the pallet being folded from a single layer of such material.

The prior art discloses numerous ideas for replacing standard wooden pallets by cardboard material pallets. Cardboard material pallets have the advantage that they can be supplied by the recipient of the product to a paper recycling circuit. However, such pallets are also increasingly used for weight reasons, because they are lighter than wooden pallets and give rise to lower transportation costs.

DE 201 03 902 U1 discloses a cardboard or corrugated board pallet having feet, which comprise several parallel and spaced runners or skids constructed in one piece with the upper section. In the folded arrangement the runners have a triangular or quadrangular cross-section.

DE 195 23 492 A1 discloses a pallet using roll cores of paper, carpet and similar material rolls as support elements, the roll cores being arranged in two-layer, superimposed and vertical manner.

Finally, WO 95/25672 discloses a pallet system comprising a flat upper section provided with tubular runners. The runners are folded from a flat cardboard. For stiffening the runners separate parallelepipedic stiffening elements are introduced into the runners and e.g. comprise wound or honeycomb-like cardboard material.

The prior art cardboard pallets suffer from various disadvantages with respect to their low strength or stability, complicated manufacture, material consumption and large transportation volume for dispatching the pallet. In addition, due to the capillary action of the cardboard material, the known cardboard pallets are susceptible to water and moisture.

There is therefore a need for a pallet which is easier to manufacture, has a greater stability, uses less or more cost effective material, which is better protected against moisture and water and which is easier to transport. There is also a need for a method for the manufacture of such a pallet, as well as for a plant for the manufacture of such pallets.

The aforementioned problems and requirements are solved by a pallet foot for a pallet according to claim 1, as well as by a pallet according to claim 11.

More specifically the aforementioned problems are solved by a pallet foot for a pallet, which is characterized in that the cardboard tube comprises wound (recycled) paper layers.

As a result of the winding of the paper layers a particularly high strength is obtained, even when using recycled paper. The use of recycled paper reduces material costs.

Such a pallet foot can also be rapidly and easily produced from an angular cardboard tube. As the starting material is a tube, which only has to be worked or processed, no additional cardboard elements have to be made and installed. The reinforcements of the load-bearing areas are provided solely by the cardboard material present in the cardboard tube. This permits an absolutely waste-free pallet foot production. The tubular starting material is also particularly stable, because it has no adhesion points, pronounced seams, etc. and is instead preferably wound in one piece. Moreover, the stiffening of the load-bearing areas by the stiffening walls creates a stable and also very lightweight structure able to withstand high loads.

In addition, the machines in cardboard and paper factories have fixed working widths, so that constantly secondary webs are produced during the production of specific paper or cardboard widths. In the case of weight changes, there are also transition webs, which are also produced as waste. These secondary or transition webs are normally returned to the waste paper circuit or cycle. This leads to high costs for the paper factory, because the secondary and transition web rolls are too compact for direct recycling and are consequently unwound or sawn at high cost.

As only narrow paper or cardboard strips with a width of approximately 7 to 140 mm are required for winding the inventive cardboard tubes, the secondary and transition webs which occur as waste during paper production can be used without any difficulty and consequently have a worthwhile utilization. Wider secondary or transition webs merely have to be cut to the requisite strip width, which is readily possible in the paper factory. As secondary webs are otherwise virtually unsaleable, they can be obtained at a very favourable price and possibly even free, which greatly reduces the material costs for the pallet feet.

The cardboard tube preferably has a quadrangular or octagonal cross-sectional shape. As a result of such shapes the pallet foot forms a planar bearing surface for a top plate of the pallet and a planar surface on the ground, so that the loads which arise can be distributed in large-area manner.

In another preferred embodiment the cardboard tube is made from a cardboard

material hardened by means of water glass. The hardening of the cardboard tube with water glass means that the pallet foot produced therefrom has a particularly high strength. In addition, water glass as a hardening and adhesive material is particularly inexpensive, because it only costs about 1/3 of the price of conventionally used adhesives. In addition, during hardening in the air water glass does not release toxic vapours. Moreover, following the hardening operation the cardboard tube is protected against water and moisture, so that the pallet can also be used in the open air.

Preferably the closed areas of the pallet feet have side walls provided with impressions running substantially parallel to the load or loading direction. The impressions or corrugations, compared with a planar surface, reinforce the side walls of the load-bearing areas and increase buckling resistance. The impressions can also pass into one another, which leads to a wave shape.

Preferably the closed areas are in each case subdivided into three or four chambers. Preferably the individual chambers of the closed areas have the same shape. The shape and number of chambers essentially determines the stability of the pallet. In addition to compressive forces resulting from the weight of the load, the preferably closed chambers can particularly well absorb transverse forces, which frequently arise during transporting and loading of the pallet.

In another preferred embodiment the stiffening walls are folded at folding grooves running parallel to the load direction. The folding grooves facilitate a precise folding of the stiffening walls. As the folding grooves run in the load direction, within the load-bearing areas the stiffening walls are vertical and therefore transfer the compressive forces which occur in the main load direction into the ground or base area.

Preferably the stiffening walls of a closed area are bonded flat to one another. A bonding of the stiffening walls increases the load of the load-bearing areas to a significant extent, because adhesion points can transfer shear forces between the stiffening walls.

The cardboard tube preferably has a continuous upper wall and a continuous lower wall, the inwardly folded side walls being bonded to the upper wall and the lower wall. The continuous upper and lower walls of the pallet foot serve as spacers and reinforcements for the load-bearing areas.

It is also preferable for the closed areas to in each case have at least one lateral window in order to link the pallet foot with a crossbar.

Specifically the aforementioned problems are also solved by a pallet having a substantially flat, planar cover plate and at least two pallet feet according

to one of the claims 1 to 11. By adding a suitable cover plate, e.g. of wood, plastic, metal or cardboard, with the pallet feet a complete pallet is obtained which is adaptable to the particular intended use.

The top plate is preferably also made from cardboard or recycled cardboard, so that a completely recyclable cardboard pallet is obtained.

In another preferred embodiment the pallet feet are adhered parallel to one another to the cover plate.

The pallet preferably has at least one crossbar which is connected to the pallet feet and runs perpendicular to the latter. As a result of such a crossbar, the pallet stability is greatly increased, so that the cover plate material thickness can be reduced. For the same load it is e.g. possible to reduce the thickness of the comparatively expensive cover plate by approximately 50%, which leads to a cost reduction of up to 20%.

In addition, the crossbars can be used or omitted as a function of needs, which provides an individually configurable pallet system.

Preferably the crossbars are made from the same cardboard tube as the pallet feet, so that the same tube winding machine can be used.

The aforementioned problems are also solved by a method for the manufacture of a pallet foot for a pallet, which has the following steps, but which does not form the object of the present patent.

1. Punching lines of cut in the circumferential surface of a cardboard tube in order to cut out stiffening walls.

2. Stamping folding grooves into the circumferential surface of the cardboard tube for forming folding grooves for folding the stiffening walls.

3. Folding the stiffening walls in order to subdivide into chambers the load-bearing areas of the pallet foot.

As a result of the method according to the invention the advantages described in conjunction with the pallet feet according to the invention are obtained.

In a preferred embodiment the method has the following steps preceding the other steps:

1. Winding a continuous cardboard tube from paper or cardboard layers.

2. Cutting the continuous cardboard tube to a desired length for forming a single cardboard tube.

Thus, starting with a paper starting material, the method produces a pallet foot with a specific length, specific strength and carrying load. The winding step can be varied in such a way that different cardboard tube wall thicknesses are obtained, so that the pallet foot has a different carrying load.

The method preferably also has the step of forming impressions in the circumferential surface of the cardboard tube, said impressions running substantially parallel to the desired load direction. The impressions or corrugations reinforce the circumferential surface of the cardboard tube.

Preferably the steps of punching lines of cut, stamping folding grooves and forming impressions are performed simultaneously, which reduces the pallet foot manufacturing time.

In another preferred embodiment the method also has the step of impregnating the cardboard tube with water glass. Preferably the paper strip from which the cardboard tube is wound is drawn through a gluing unit and one side of the paper strip is coated over its entire surface with water glass. The use of water glass as the adhering and hardening material is made possible in that immediately after the winding process the "compressing-stamping-punching process" is performed. As a result of tube compression an absolute bond is obtained, which in the case of conventional winding can only be brought about by cost-intensive aftertreatment using high-grade adhesives. In particular, the cardboard tube winding can take place at a much higher winding speed than in conventional methods, because any air voids or bubbles between the paper webs to be bonded can be expelled through the compression of the tube.

In a further preferred embodiment the method has the step of compressing and heating the cardboard tube so as to harden the latter in void-free manner. Preferably the compressing and heating step is performed simultaneously with the punching-stamping step. During compression the cardboard fibres are retained and the cardboard surface is smoothed, so that the pallet foot has reduced moisture absorption. As a result of heating the pallet foot drying time is reduced to such an extent that immediate further processing can take place. In the case of conventional drying, it would otherwise be necessary to respect drying times of up to two weeks.

The method preferably also has the step of applying adhesives to partial areas of the stiffening walls, so as to bond the latter together.

The aforementioned problems are also solved by an installation or plant for

manufacturing pallet feet having a tube processing machine for punching lines of cut and introducing folding grooves into a circumferential surface of an angular cardboard tube and a folding machine for folding stiffening walls along the folding lines for the purpose of forming the load-bearing areas of a pallet foot.

As a result of such a plant it is possible to rapidly and inexpensively produce pallet feet from cardboard tubes. The plant can operate completely automatically, so that it is possible to produce a large number of pallet feet with low piece costs.

The plant preferably also has a tube winding machine for producing a continuous cardboard tube and a cutting device for cutting the continuous cardboard tube, so as to give a cardboard tube with a desired length.

In another preferred embodiment the tube processing machine has an inner tool, which can be inserted into the cardboard tube and where said inner tool can be radially expanded to engage on the inner wall of the cardboard tube.

The inner tool preferably has replaceable working surfaces for grooving, stamping and punching or cutting. The working surfaces of the inner tool can consequently be easily replaced in the case of wear.

Preferably the inner tool also has at least one electrical heating element. Through said heating element the inner tool can be heated in order to aid hardening of the water glass-impregnated and therefore moist cardboard tube. Therefore the cardboard tube is virtually "baked" or pressed into shape.

In another preferred embodiment the processing machine has outer tools, which comprise replaceable punching tools for punching lines of cut in the circumferential surface of the cardboard tube and replaceable stamping tools for making folding grooves in the circumferential surface of the cardboard tube. As a result of the cooperation between the outer and inner tools, the cardboard tube is compressed to such an extent that air is forced out between the cardboard tube paper layers and an optimum paper web bonding takes place.

The outer tool preferably has replaceable stamping tools for making impressions.

Preferably the plant also has edge cutters for punching longitudinally directed lines of cut in the circumferential surface of the cardboard tube.

The folding machine preferably has vacuum exhausters in order to bend the stiffening walls outwards from the circumferential surface of the cardboard tube. The vacuum exhausters are merely placed on the cut-out side wall areas

of the cardboard tube and vacuum is applied for the purpose of gripping the stiffening walls and bending them outwards.

The folding machine preferably has motor-driven turn-in claws, in order to fold the stiffening walls into the load-bearing cardboard tube areas. Following the bending up of the stiffening walls by means of the vacuum exhausters use can be made of turn-in claws in order to fold the stiffening walls to their desired shape.

Preferably the turn-in claws are turned by stepping motors and moved pneumatically up and down.

The problem of space-intensive transportation of the finished pallet is solved by a method for the manufacture of a pallet, said method having the following steps in the indicated order:

1. Shaping blanks from an angular cardboard tube.

2. Dispatch of the blanks to the end user.

3. Fixing the blanks to a suitable cover plate on the premises of the end user.

As the final method step is only performed by the end user, the comparatively bulky pallet is only obtained at this time. During dispatch to the end user the blanks only take up a limited space, so that shipping costs are low. A lorry or truck can usually load 800 empty Europa-size pallets. On dispatching the blanks approximately 8,000 individual systems can be transported in each lorry and they are then installed on the premises of the end user.

Preferably the blanks are pallet feet or crossbars and it is then left to the end user to decide which top or cover plate he wishes to use, e.g. of wood, plastic or cardboard. Moreover, as a function of the load to be transported, he has flexibility concerning the number of blanks required. For example, instead of three, in the case of light loads he may only use two feet per pallet, which would mean a material saving of approximately 30% per pallet. As a function of the load, the end user can also decide whether or not crossbars are to be used.

In another preferred embodiment the method also has the step of delivering the cover plate to the end user. Therefore the end user receives a complete construction set for a pallet.

For the same dimensions, an inventive pallet preferably only has a weight of

approximately 3.5 kg, compared with a wooden Europa pallet weighing approximately 11 kg. Therefore these pallets can also be handled by female workers. In addition, a gas treatment such as is prescribed for export uses is rendered unnecessary, which further reduces manufacturing costs.

4. Brief description of the drawings

Preferred embodiments of the present invention are described hereinafter relative to the attached drawings, wherein show:

Fig. 1 An inventive pallet in a three-dimensional view according to a first, preferred embodiment of the invention with pallet feet according to the invention.

Fig. 2 Two side views of a preferred embodiment of a pallet foot according to the invention, the upper side view showing folding lines and the lower side view lines of cut.

Figs. 3A to 3E Horizontal sectional views through load-bearing areas of preferred pallet feet, different stiffening wall folding variants being shown.

Fig. 4 A horizontal cross-sectional view through a tube processing machine for processing cardboard tubes, but which is not an object of the present patent.

Fig. 5 A cross-sectional view through an outer tool of a preferred tube processing machine.

Fig. 6 A three-dimensional view of an outer tool.

Fig. 7 A longitudinal cross-sectional view through an inner tool of a preferred tube processing machine.

Fig. 8 An axial cross-sectional view through a preferred cardboard tube and an inner tool of a preferred tube processing machine.

Fig. 9 A cross-sectional view through a partial area of a tube processing machine showing the cardboard tube, outer tools, inner tool and edge cutter.

Fig. 10 A three-dimensional view of a cardboard tube with inner tool, as well as a preferred edge cutter.

Fig. 11 At the top a top view of a folding tool of a folding machine

and at the bottom a side view of the folding tool, as well as a cardboard tube stiffening wall.

Fig. 12 A turn-in claw engaged with a stiffening wall.

Fig. 13 A side view and eight top views of a preferred embodiment of a pallet foot for illustrating the stiffening wall folding in process.

Fig. 14 A top view of a preferred embodiment of a pallet foot manufacturing plant.

Fig. 15 A side view of the plant of fig. 14.

Fig. 16 A second embodiment of a pallet in side view, crossbars being used in addition to the pallet feet.

Fig. 17 An assembly diagram in plan view of a pallet using three pallet feet and six crossbars.

Fig. 18 A side view of a cardboard tube provided with folding grooves and lines of cut.

Fig. 19 The end region of a crossbar in a three-dimensional view.

Fig. 20 A cross-sectional view of a crossbar.

5. Detailed description of preferred embodiments

Preferred embodiments of the present invention are described hereinafter with reference to the drawings.

Fig. 1 shows a pallet 1 comprising a substantially flat, planar cover or top plate 50 and three pallet feet 10, which are preferably fixed under the top plate 50. Preferably use is made of three pallet feet 10, which are parallel to one another. Two pallet feet 10 are fixed to the edge of the cover plate 50 and one pallet foot 10 in the centre of the cover plate 50. Fixing can take place by different methods, but preference is given to sticking or bonding the pallet feet 10 to the cover plate 50.

As a function of the intended use of the pallet 1 and the maximum planned loading, it is also possible to use only two pallet feet or more than three pallet feet.

The pallet feet 10 essentially comprise a one-piece cardboard tube 11 with an

angular cross-section. Fig. 1 shows cardboard tubes 11 having a square cross-section, whereas figs. 8 to 15 show cardboard tubes with an octagonal cross-section. It would obviously also be possible to have hexagonal or more-angled cross-sections, but the bearing surfaces of the pallet foot 10 towards the cover plate 50 should be planar, so that the pallet feet can be reliably bonded to the cover plate 50.

Pallet foot 10 of fig. 1 reveals three closed, load-bearing areas 30, which are preferably parallelepipedic, as well as two open areas 20 between the load-bearing areas 30. The open areas provide a transverse, i.e. transversely directed passage through the pallet feet, so that the pallet can also be taken up by the forks of a fork-lift truck in the transverse direction.

Pallet foot 10 has a continuous upper wall 16, with which the pallet foot 10 is bonded to the cover plate 50, as well as a continuous lower wall 14 interconnecting and spacing the load-bearing areas 30 in order to improve the stability of the pallet foot 10.

Each pallet foot 10 comprises a cardboard tube 11 with an angular cross-section, which can be a specially wound cardboard tube or a cardboard tube obtained as waste product during paper or cardboard manufacture. Preferably, for winding the cardboard tube, use is made of recycled or waste paper from secondary or transition webs, which can be preferably impregnated or coated with water glass prior to winding in order to give an increased strength to the subsequent pallet foot 10.

Water glass is obtainable as potassium water glass (potassium silicate K_2SiO_3) or as soda water glass (sodium silicate Na_2SiO_3) and in the form of a syrupy solution of sodium or potassium silicate in water. Water glass hardens completely in air and serves as an inorganic binder giving the cardboard tube 11 and pallet foot 10 increased strength and moisture resistance. Water glass is used as a component for bonding, hardening and moisture-protecting the pallet feet. Moisture protection can be further increased if the pallet feet are immersed 20 to 30 mm from their underside or completely in water glass. As a result of the punching precision, no water glass can penetrate the interior of the load-bearing areas 30.

Fig. 2 shows how a cardboard tube 11 is provided with folding grooves 36 and lines of cut 38 in order to make a pallet foot 10 therefrom. The upper view in fig. 2 shows a side wall of an angular cardboard tube 11 with subsequently load-bearing areas 30 and stiffening walls 32 folded from the side wall of the cardboard tube 11. The upper view of fig. 2 also shows the broken line folding grooves 36 made in the cardboard tube 11 in order to facilitate folding of the stiffening walls 32 at said grooves 36.

The lower view of fig. 2 shows the lines of cut 38 required in order to cut or punch out the stiffening walls 32 from the side walls of cardboard tube 11.

For stiffening the load-bearing areas 30 of each pallet foot 10 and for increasing the bearing capacity thereof, partial areas of the side walls of cardboard tube 11 are folded as stiffening walls 32 into the load-bearing areas 30. Thus, in the vicinity of the load-bearing areas 30 within the tube in each case a plurality of chambers 34 is obtained.

Preferred examples for the shape of such chambers 34 and preferred folding patterns are shown in figs. 3A to 3E. Figs. 3A to 3E are horizontal cross-sections through in each case a load-bearing area 30. Preferably flat-abutting areas of the stiffening walls 32 are bonded together, so that the stiffening effect is significantly increased. For bonding together the stiffening walls 32 and also for bonding to the cover wall 16, bottom wall 14 and side views 17 of the pallet foot it is possible to use a standard paper adhesive, hot melt adhesive, etc. Preferably water glass is also used for this purpose.

The gap between the stiffening walls 32 shown in figs. 3A to 3E merely illustrates the corresponding folding pattern and is in reality not present or is not present to such a marked extent.

Fig. 3A shows a first folding variant, in which the reinforcements 32 are folded inwards at three folding grooves 36 in order to form a cruciform stiffening structure within the closed area 30, the stiffening walls running along the lines of symmetry of the closed area 30. Therefore the closed area of fig. 3A is subdivided into four substantially equally large chambers 34.

Fig. 3B also shows a cruciform arrangement of the stiffening walls 32, but one stiffening wall is not duplicated.

Fig. 3C shows a variant in which two elongated chambers are formed, one chamber being centrally partially subdivided by stiffening walls.

Fig. 3D shows an embodiment in which the stiffening walls 32 form three closed chambers 34 arranged in the longitudinal direction of the pallet foot 10. As a result of the large overlapping areas of the individual stiffening walls 32, said embodiment provides a very good stiffening action.

The same applies regarding the embodiment of fig. 3E, where as a result of the bending of two ends of the stiffening walls 32 towards the side wall, there is a more uniform stiffening of the load-bearing areas 30.

Obviously other folding patterns are conceivable for folding the punched out side walls 32 of cardboard tube 11 into the load-bearing areas 30 in order to form a plurality of chambers 34.

Fig. 4 shows a horizontal cross-sectional view through a tube processing machine 110. In the embodiment shown the tube processing machine 110 comprises two inner tools 111 and two outer walls 114 which can be pressed by hydraulic cylinders 130 in the direction of the inner tools 111 in order to compress, stamp, groove and cut the cardboard tube 11. The inner tools 111 are introduced laterally into tube 11 and are expanded by two pressure cylinders 140. Following expansion, the inner wall 18 of cardboard tube 11 engages on the outside of the inner tool 111.

Fig. 5 shows a detail of an outer tool 114 and two pressure cylinders 130. Fig. 6 provides a three-dimensional representation of the outer tool 114. Figs. 5 and 6 show that the actual tools 115, 116, 117 of outer tool 114 are built up from elongated, profile-like elements, which are screwed to a continuous support plate. Thus, when necessary, it is possible to replace the specific tools 115, 116, 117 of outer tool 114.

An outer tool 114 comprises cutting tools 115 for cutting lines of cut 38 into the circumferential surface of cardboard tube 11, punching tool 116 for making folding grooves 36 in the circumferential surface of cardboard tube 111 and stamping tools 117 for making impressions 39 for stiffening the circumferential surface of cardboard tube 11. The stamping tools 117 are preferably rounded at their working surface, so that there is a slight corrugation of the lateral face of cardboard tube 11, but no sharp edges are introduced which could aid buckling.

Fig. 7 is a longitudinal section through inner tool 111 and illustrates how radial expansion can take place therein. To this end the inner tool 111 comprises a pressure cylinder 140, which moves a wedge-shaped element 141, which can be moved between two wedge-shaped outer elements 142. During this sliding in movement the wedge-shaped outer elements 142 move away from one another in parallel. The expansion of the inner tool 111 is limited by two stops 143, so that the cardboard tube 11 can be firmly fixed to the inner tool, but does not tear.

Fig. 8 shows a cross-section through inner tool 111 and through cardboard tube 11. Fig. 8 more particularly shows electrical heating elements 113 making it possible to heat the inner tool. Thus, it is possible to accelerate or even complete the external hardening process of the water glass-impregnated cardboard tube 11. Thus, at a temperature of approximately 80 to 120°C in the tube processing machine, the cardboard tube 11 is virtually "baked". Any air trapped between the paper layers is expelled.

Fig. 8 also shows replaceable working surfaces 112 corresponding to working tools 115, 116, 117 of outer tool 114. If necessary, working surface 112 can also be replaced.

Fig. 9 shows a cross-section through a tube processing machine 110 and in this case use can be made of four outer tools 114, so as to be able to work all four sides of cardboard tube 11. In order to make the longitudinal cuts for the stiffening walls, the tube processing machine is equipped with cutting tools 118 which introduce into cardboard tube 11 the longitudinal cuts of stiffening walls 32.

Fig. 10 shows an exemplified cutting tool 118 in a three-dimensional view and said tool 118 can be moved in the direction of inner tool 111 by two pressure cylinders 130. Fig. 10 shows a further embodiment of S-shaped impressions 39. A line of cut 38 produced by cutting tool 118 is also symbolically represented.

During the stamping process the continuous upper 16 and lower 14 walls also are given a not shown stamping, which increases the stability of both walls, particularly against sagging. As a result of the stamping operation the stiffening walls 32 are fixed internally and may not have to be bonded together. In addition, there is a reduction in the bearing surface of pallet foot 10 with respect to the cover plate 50, which makes it possible to improve bonding due to a higher contact pressure and the use of adhesive can be reduced.

As a result of such a stamping, there is a reduction to the bearing surface on the ground, so that moisture absorption is further reduced. In addition, damage to the pallet as a result of lift truck introduction is avoided, because the lift truck wheels are passed into the free spaces provided as a result of the curvature of the cardboard wall. Such a construction also permits the use of the pallet on automatic transport lines, as well as insertion and removal with respect to automatic storage areas.

Fig. 11, top, is a top view and at the bottom a side view of a folding in device 127 of a folding machine 120 for folding stiffening walls 32. A folding machine 120 has the same number of folding in devices as there are stiffening walls 32. In the presently described embodiment there are twelve folding in devices 127.

The folding in device 127 comprises two turn-in claws 122, 123, shown in detail in fig. 12. The turn-in claws 122, 123 can be mounted on the edge of a stiffening wall 32 in order to fold the latter along folding grooves 36. For this purpose the turn-in claws 122, 123 can be moved pneumatically up and down in order to grip the edge of stiffening wall 32.

The folding in device 127 also comprises two stepping motors 124, 125, which in SPC-controlled manner turn the turn-in claws 122, 123. The left-hand stepping motor 124 turns the entire folding in device 127 and the right-hand stepping motor 125 turns a turning or rotating disk 126, which has a turn-in claw 123 and the associated pneumatics for moving up and down.

With the aid of such folding in devices 127 and vacuum exhausters 121 the folding in process for all the stiffening walls 32 of pallet foot 10 takes place automatically and simultaneously. The folding in process is illustrated in exemplified manner in steps 2 to 9 in fig. 13.

The top view of fig. 13 again shows in exemplified manner a punched cardboard tube 11 provided with folding grooves 38, steps 1 to 8 being shown in top view.

Prior to the folding process, adhesive is applied to the areas of stiffening walls 32 to be bonded.

In working step 1 the vacuum exhausters 121 are placed on the punched side walls 32 of cardboard tube 11 and vacuum is applied to apply a suction to side walls 32. In working step 2 the vacuum exhausters 121 are pivoted outwards and the stiffening walls 32 are folded outwards, i.e. away from cardboard tube 11. In working step 3 the turn-in claws 122, 123 are placed on the edges of stiffening walls 32 in that the turn-in claws 122, 123 are moved pneumatically downwards. In fig. 13 the turn-in claws are symbolized by black or white circles. Simultaneously the vacuum exhausters 121 are removed by cancelling out the vacuum.

In working step 4 the outer turn-in claws 122 are turned in, so that the initial folding takes place at a first folding groove 26. In working step 5 the outer turn-in claws are removed, i.e. moved upwards and the central turn-in claws are turned in in order to carry out a second folding if this is desired.

In working step 6 all the turn-in claws are removed by pneumatically raising them. In working step 7 the stiffening walls 32 are folded automatically into the load-bearing areas 30 by pressure from the outside by means of the folding device and as symbolized by the arrows.

Finally, in working step 8 the remaining end members 37 are folded downwards and upwards and bonded to the stiffening walls 32.

Fig. 14 is a plan view of an installation or plant 110 for the manufacture of pallet feet 10. The plant 100 comprises a tube winding machine 150, which winds winding paper 13 to a continuous cardboard tube 12 with an angular

cross-section. Preferably the continuous cardboard tube 12 and therefore also the cardboard tube 11 has five to 20 paper layers, as a function of the requisite bearing load of pallet foot 10. Thus, a wall thickness of approximately 3 to 5 mm is obtained, which as a result of the special manufacturing method can be thinner than in the case of conventionally produced cardboard tubes, which for the same strength have a wall thickness of 12 to 15 mm. The continuous cardboard tube winding paper is coated on one side with water glass using a gluing unit in tube winding machine 150 before winding up takes place.

The continuous cardboard tube 12 is delivered by the tube winding machine 150 and cut by a cutting device 160 into cardboard tubes 11 having a desired length. Preferably the cardboard tube 11 has a length of 1.40 metres.

After cutting off, the cardboard tube 11 drops onto a first conveyor belt 170, from where it is conveyed onto a second conveyor belt 180, in the manner symbolized by the arrows. The second conveyor belt conveys the cardboard tube 11 to the given processing lines. In fig. 14 only a first processing line is completely represented and a second line is intimated, but they can be upwardly followed by further processing lines.

Level with the first processing line, by means of an ejector 185 cardboard tube 11 is conveyed from the second conveyor belt 180 to a tube depot 200. If there is an overcapacity of tubes, then the cardboard tubes 11 are collected at the end of conveyor belt 180 in a not shown magazine. If required, the cardboard tubes 11 can be supplied to the second conveyor belt 180 again via a further tube depot 190.

From tube depot 200, the cardboard tubes 11 are gripped by means of a first transport cross 210 by a vacuum exhauster and conveyed to the tube processing machine 110. For this purpose the transport cross 210 moves upwards and rotates by 180°. The vacuum is then removed and the cardboard tube 11 drops into the tube processing machine 110. The transport cross 210 then returns to its starting position.

The working process in connection with cardboard tube 11 commences in tube processing machine 110. The six pressure cylinders 130 to the right and left move to "fixing", cardboard tube 11 only being gently held and is not compressed. By means of toothed gear transporters 145 the inner tools 111 are speedily introduced into the cardboard tube 11. Simultaneously the upper pressure cylinder 135 (cf. fig. 15) speedily drops onto a further toothed gear transporter 146. Toothed gear transporters 145, 146 are locked in order to apply an adequate counterforce for the corresponding pressure cylinders 140, 135. Pressure is now hydraulically or pneumatically supplied to pressure cylinders 130, 135 and 140 and they move into the "working

position". In this position all the folding grooves 36, lines of cut 38 and impressions 39 are simultaneously made in the circumferential surface of cardboard tube 11. Simultaneously the material of cardboard tube 11 is compressed to such an extent that air between the paper webs is forced out. Then, or even earlier, the electric heating elements 113 of inner tool 111 are activated, so that the latter is heated and the cardboard tube 11 is dried and therefore hardened.

Following the hardening of cardboard tube 11, or even after a partial hardening, pressure cylinders 130, 135, 140 and toothed gear transporters 145, 146 are moved back into their starting position.

The completely cut cardboard tube 11 provided with folding grooves 36 and impressions 39 is then conveyed by a second transport cross 220 from tube processing machine 110 to folding machine 120, where the aforementioned, requisite folding processes are performed.

The pallet feet 10 are now finished and are conveyed by a third conveyor belt, which links all the existing processing lines to a not shown depot.

The pallet feet 10 can then be bonded with a suitable cover plate 50 to give a pallet 1. Preferably, however, this final assembly step does not take place directly following the manufacture of the pallet feet 10, but instead only on the premises of the end user. For this purpose the finished pallet feet 10 are sent to the end user separate from the cover plates 50. The end user can then carry out the final assembly (bonding, joining together, tacking, etc.). This reduces the transport volume to a minimum and the transportation costs for dispatching the pallets are minimized.

It is obviously also possible to carry out the final assembly of the pallets by the manufacturer of pallet feet 10, in the case where the end user does not wish to carry out the assembly process.

Fig. 16 shows another preferred embodiment of a pallet 1, where crossbars 300 are placed between the pallet feet 10 to increase further the stability of pallet 1.

Like the pallet feet 10, the crossbars 300 comprise a wound cardboard tube 11. The necessary cardboard tube can be produced on the same tube winding machine 150 as the tubes 11 for pallet feet 10. By punching, grooving and stamping, in each case two crossbars 300 can be made from one cardboard tube 11 of the requisite length.

Fig. 18 is a side view of cardboard tube 11 with stamped in, longitudinally directed folding grooves 304 and punched in lines of cut 302. The lines of

cut 302 subdivided the cardboard tube 11 into an upper half 305 and a lower half 306, which in each case provide a crossbar 300. On punching the lines of cut 302 simultaneously the ends of the cardboard tube are trimmed (not shown), so as to be able to subsequently form pegs 310, as shown in fig. 19.

As is shown in a cross-sectional view in fig. 20, the lateral faces of the cardboard tube halves 305, 306 are folded inwards along the folding grooves 305 in order to double the side wall thickness of the U-shaped crossbars 300. Subsequently pegs 310 are formed at the ends of crossbars 300, in that the double side walls are outwardly enveloped at the end in the manner shown in fig. 20.

For joining the pallet feet 10 to the crossbars 300, in their load-bearing areas 30 the feet 10 are equipped with side windows 22, which are also punched in the manner shown in fig. 16. On assembling the pallet 100 with crossbars 300, the pegs 310 are inserted in the side windows 22 of pallet feet 10 and, if necessary, bonded with water glass. To this end the open side of the U-shaped crossbars 300 are preferably directed upwards towards the cover plate 50 and their upper edge engages on the latter.

The crossbars 300 are produced in the same way as the pallet feet 10 using a corresponding plant. The crossbars 300 are also compressed, punched, grooved and given impressions in a single operation by means of the tube processing machine 110, provided that this is desired. Subsequently and using a folding machine 120, the folds are made in side walls and pegs 310.

Reference numerals list

1	Pallet
10	Pallet foot
11	Cardboard tube
12	Continuous cardboard tube
13	Paper layers
14	Lower wall
16	Upper wall
17	Side wall
18	Inner wall
20	Upper areas in cardboard tube
22	Side window
30	Closed, load-bearing areas in cardboard tube
32	Stiffening walls
34	Chambers
36	Folding grooves
37	End members

38	Lines of cut
39	Impressions
50	Cover plate
100	Plant
110	Tube processing machine
111	Inner tool
112	Working surfaces
113	Electric heating element
114	Outer tools
115	Cutting tools
116	Stamping tools for folding grooves
117	Stamping tools for impressions
118	Edge cutter
120	Folding machine
121	Vacuum exhauster
122	Turn-in claws
127	Folding in device
130/135/	Pressure cylinders
140	
141	Wedge-shaped, inner element
142	Wedge-shaped, outer element
143	Stop
145/146	Toothed gear transporter
150	Tube winding machine
160	Cutting device
170	First conveyor belt
180	Second conveyor belt
185	Ejector
190	Second tube depot
200	First tube depot
210	First transport cross
220	Second transport cross
230	Third conveyor belt
300	Crossbar
302	Line of cut
304	Folding grooves
305	Upper half
306	Lower half
310	Peg